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NATURAL COLD STORAGE IN THE CANADIAN NORTH

by

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FOREWORD

The recent expansion of civil and military activities in the far North has increased the value of the information gathered for this paper. Many queries have been received by the Defence Research Board concerning this method of storage. Cold cellars similar to those described have been used with considerable success by the "arctic contractors" on the U.S. Navy petroleum reserve at Point Barrow, for the storage of large amounts of frozen meat. It is hoped that this document will stimulate interest in this method of cold storage.

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Introduction

The use of natural cold storage in perennially frozen ground has probably been known in Siberia for several centuries. In Alaska, however, the earliest authoritative reference seems to be due to William Healy Dall, who, in 1866, stated that immense quantities of meat and fish were preserved without taint all year round in excavations in the frozen ground of the lower Yukon. He expressed surprise that the practice did not seem to have been known to early explorers. By 1885, natural cold storage was certainly in use at Point Barrow on the Alaskan Coast, because Bishop S.H. Gapp mentions "large rooms cut into perpetual ice, one for each village, abolishing the local custom of storing blubber, meat, and skins above ground where they soon become rancid".

With natural cold storage in general use in Alaska, its introduction by American whalers at several points along the Canadian Arctic Coast was an obvious measure. Vertical excavations, which had been used for this purpose, still exist at several points that have been whaling stations. These include Herschel Island, Cape Bathurst, Cape Parry, Langton Bay, Tom Cod Bay, and Banks Island. On the withdrawal of the whaling fleet from Arctic waters, the storage was used by traders and others for a number of years, until the depopulation of that part of the coast caused most of them to fall into disuse.

The great advantage of being able to keep meat and fish fresh for long periods was, however, recognized and adopted quite widely throughout the western Arctic, especially where soil conditions were favourable for excavating.

Distribution of Storage

Particulars have been received of natural cold storage at several places in the Canadian Northwest (Appendix A). The greatest concentration of this type of storage is in the Aklavik area and is, of course, a result of the large local population, of ground conditions that make excavation relatively easy, and also of the practice in this area of storing winter ice underground to be used throughout the summer as a source of water in preference to the river. It will be noticed that east of Cape Parry there is little storage. The reason for this is that a transition to glacial drift takes place at this point, and the large boulders make excavation of storage space more difficult than in the silt and clay deposits to the west.

Types of Storage

Two types of storage cellar are in use – one is a deep, vertical excavation below the top of the permafrost, and the other is a horizontal tunnel. The former method is more satisfactory and is always adopted where possible.

Excavation of a vertical shaft is usually done during the winter months as the frozen silt can be removed quite easily without danger of cave-in or of surface water interfering with the work. The low winter temperature prevents melting inside the shaft. Below a depth of 6 ft., the shaft is widened as it goes down, forming a storage space from 8 to 14 ft. square at the bottom, which is commonly at a depth of around 20 ft. Double trap-doors are built into the entrance to the shaft, which is usually framed with logs. The wider part of the shaft is frequently divided into two storeys, the upper being used to freeze cuts or carcasses individually before they are placed in the lower chamber for storage. A slanting roof of logs is usually built over the site and extended to form an entrance porch in which double doors are built. The roof is covered with an insulating layer of turf approximately 6 in. thick, and the excavated material is heaped over this structure. A typical storage cellar of this type is shown in Fig. 1.

The excavation of a horizontal tunnel is an easier matter, particularly in rocky terrain. It suffers, however, from the grave disadvantage that it is impossible to prevent the escape of cold air in the summer. As a result the temperatures within such tunnels are not low enough for satisfactory storage over long periods. A modification of this method, which has been successfully used in the Canadian Arctic, takes the form of a comparatively shallow excavation in a sand or gravel ridge. Meat may be preserved if placed in such a trench and covered with the excavated material and an additional layer of sand or gravel, though after one or two summer months it will become tainted.

Factors Affecting Storage

The principal factors that adversely affect the wider use of cold storage in the North are the difficulty of excavation, which must be done under winter conditions, and the keeping of the cellar temperature below the critical temperature of 15°F, which has been found necessary to prevent the growth of mould on stored meat. Mould is a living organism, and is dependent on temperature and presence of moisture. With conditions of high relative humidity, it is likely to grow at any temperature above 15°F, though with drier conditions somewhat higher temperatures may be accepted.

Though the vertical shafts are carried down into the permafrost, the upper part of the cellar may be in the "active layer" of the soil. As thawing takes place in the summer, seepage into the excavation will begin, and, as there is an appreciable "lag" between surface and soil temperatures at various depths, thawing may continue for several months. To overcome this, it is advisable to cover the excavated area with moss or other good insulating material in order to bring the active layer above the level of the top of the cellar.

Drainage of the surrounding area is also important, and care must always be taken to ensure that the entrance to cold-storage rooms is higher than the surrounding ground to prevent seepage of water into the underground chamber.

Aklavik

The ice cellars of Aklavik were first dug to provide storage for winter ice, which was then used as a source of drinking water. As the resident population increased, the need for additional space for storage of meat within the settlement led to wider use of natural cold storage.

The Roman Catholic and Anglican Missions have deep cellars in the frozen ground, as they have a storage requirement for several tons of reindeer or caribou meat for the hospitals and boarding schools.

Dr. L.D. Livingstone, who at one time was Medical Health Officer at Aklavik, writes as follows:

> "As you know, I had developed the underground cold storage at Aklavik both at the medical headquarters there and also on my local farm. These plants were built in similar style to those already in existence there, only built on a larger scale. My farm plant contained two chambers, one for deep freezing and the upper one for cooling purposes, with a building on top. This unit of mine was intended for the manufacture of milk products, but as I left about the time I was ready to produce, nothing much was done. At Aklavik I have frozen deer meat within twenty-four hours in the month of July.
>
> "Regarding the use of these storage plants in the Eastern Arctic, i.e. Baffin Land or Hudson Bay, I might say that, although we know of this Western Arctic idea, we were handicapped by the rock formation. However, there are areas such as Pond's Inlet where excavations could be made. At Pangnirtung it would necessarily mean blasting."

In a personal communication, Mr. W.P. Johnston, Hudson's Bay Company, Fort Resolution, writes of his experience with natural cold storage on the Arctic Coast and contributes excellent sketches of three cold-storage rooms.

Cape Bathurst

"The staff of the Hudson's Bay Company at Baillie Island post erected an ice-house for storing meat and fish at Cape Bathurst during the fall of 1928. This was built on the plan of one previously built by the whalers at Southwest Sandspit, an old whaling winter harbour on the southwest tip of Baillie Island. This cache, being built close to the high water level, was demolished by repeated storms over a period of years, washing out the bank.

"The attached sketch plan (Fig. 2) shows in detail the manner of construction. Fortunately for natural refrigeration purposes, the permanent ground ice at Cape Bathurst is to be found about 20 in. below the soil. Along the shore, this ice is constantly exposed to view, and can be chopped out of the bank and used in an emergency for cooking.

"A shaft approximately 6 ft. square was sunk in the ground to the 6-foot level; this space was then extended on either side to form a chamber 12 ft. in diameter and 8 ft. from the bottom of the shaft, making a total depth of 14 ft. from the surface. A slanting roof was built of split drift logs, resting on the log supports of the entrance porch. This porch was composed of an inner and outer door, and lined with drift logs. The roof and entrance porch were then covered with two layers of tarred paper before adding layers of sod. Each sod measured 12 in. square and 6 in. thick – the entire exposed surface being covered to a depth of 2 ft. Both doors were built about 8 in. off the ground – one at either end of the porch and each opening inward. As there was a slight slope in the ground toward the rear of the building, a small drain was dug all around, so that any moisture from spring thaw could run off. A small ventilator with an opening 3 in. square was placed in the roof.

"As the ice-house was used mainly for storing quantities of fish for winter dog feed, some method had to be adopted to prevent meat and fowl being tainted by the fish. Belaying pins from an old whaling vessel were driven into the walls and used for hanging up fowl; openings 3 ft. in depth and 4 ft. long were dug through the ice wall to hold meat for mess use.

"The fish run at Cape Bathurst Sandspit usually comes in the latter part of August when large quantities of Californian Herring are caught with sweep nets (150 to 200 ft. long).

"These fish were taken over to the ice-house in lots of about 500 and spread over the floor to freeze. Two days later they were frozen enough to be stacked like cordwood.

"Although no record was kept of the temperature in the ice-house, it is estimated that it must have been in the region of 10° above zero (Fahrenheit). During the time the writer used this ice-house (four years) there was no trouble with water seepage, although each year we had to break off long icicles suspended from the roof, and sweep off with a broom frost which was no doubt caused by our breath and from the heat of the lamp used for illumination while we were at work.

"In the spring after all the fish had been removed, the ice floor was chopped clean, and all dirty ice, pieces of old fish, etc., cleared away in readiness for the new season's fish."

Herschel Island

The ice-houses in use at Herschel Island by the R.C.M.Police and by the Hudson's Bay Company were originally built by the whalers, and were of similar type to that described above. These houses were spoiled for refrigeration purposes one summer by being filled with a large quantity of freshly caught seal – one alone containing almost two hundred. The heat generated by this number of seals caused the ice to thaw, with the result that the ice-houses were found to be half filled with water the following spring.

These ice-houses or caverns were dug into the side of hills with natural drainage on either side. The entrance was gained through a passage into the cold chamber, sloping downwards, 12 ft. in length. Through the years this passage had become coated with ice, and steps had to be cut régularly for safe footing. The roof supports were huge drift logs, a foot in diameter.

Information from Inspector H. Larsen and W.P. Johnston

During the spring of 1948, Inspector H. Larsen, of the R.C.M.P. *St. Roch*, removed 4 to 5 ft. of ice from one of them. These ice-houses had been used for summer storage of seals, which were removed before freeze-up. No proper care of the houses was taken by the transients who has made use of them, so that they soon filled with water, which afterwards froze.

Mr. E.J. Gall, Hudson's Bay Company, Waterways, Alta., who has travelled extensively in the Arctic, passed on his experience in the use of natural cold storage in a personal communication.

> "Houses or excavations with cappings in permafrost have been used extensively with great success from Teller, Alaska, to Bernard Harbour in the Central Arctic. There, the silty sand formation gives way to bare rock and glacier boulder formation, making it difficult to dig manually, but with modern machinery and blasting methods, that should form no great handicap. East of Bernard Harbour the so-called ice-houses are shallow excavations, cribbed over with lumber and covered with soil or moss. If meat is placed in this type of ice-house in April it will keep quite frozen until about August first when the sun's rays will gradually have penetrated the conical shaped roof with obvious results.

"It is better, from my experience, to construct the ice-house in winter, as the clay soil may be loosened with a pick and no surface water can interfere with work, and the exposed hole has no chance to thaw or cave in. A depth of 20 ft. or more is desirable. This gives a two-story freezing unit, the upper to freeze the cuts or carcasses individually and the lower floor for permanent storage.

"Drift logs may be used for cribbing and flooring purposes, and a ventilator to the surface is essential."

Ground conditions in the Liverpool Bay locality are particularly good for underground storage. Mr. A. Figgures, Hudson's Bay Company, Minaki Post, submits the following information:

"The best freezing house I have seen was located at the "neck" of the Nicholson Peninsula, sometimes referred to as Nicholson Island. It was dug by the late Stan Mason after a reindeer herd had been moved to that location. Three feet of overburden was first removed, then the house was chiselled out of the solid ice underneath to a depth of 6 ft. Stan claimed that this house would freeze meat quickly and keep it in a fresh condition. It was far superior to the houses on Cape Bathurst, and as far as I can remember there was not the same amount of hoar-frost forming inside and the air was much purer."

F/L S.E. Alexander of the R.C.A.F. has had considerable experience with natural storage at different points in the Western Arctic. He gives the following information on the construction and maintenance of underground storage houses:

"A hole is excavated to about 15 or 20 ft. in depth and may be any size in width, although generally about 8 ft. square. A roof built of planks and heavy layers of sod or earth up to 8 ft. in depth (never less than 4) is laid over all, leaving a shaft for entry. A trap-door is fitted into the top of the chamber thus formed and a close-fitting heavy second trap door is placed at the top of the shaft, which is built of timber. The latter is large enough for easy ingress.

"The ice-house is generally built just before colder temperatures set in and is left open all winter, not being used until the following Spring, allowing the permafrost to form solidly. From then on, fish, whole seal, caribou, geese, ducks, whale meat, ice-blocks, etc. are stored within. The fresh meat and fish freeze solidly in a short time, and the ice which is used for drinking water never thaws. The ice-house must not be overloaded at any one time with fresh meat or fish as freezing will not take place before spoilage sets in. Roughly it is considered that about 15% of the cubic content may be used safely for storage and freezing at any one time.

"In the fall after freeze-up commences, the ice-house is left open to take on outside temperatures, and this may be repeated several times until winter temperatures prevail. If this is not done, some process takes place whereby heat is generated in the ice-house and the contents will spoil. An abandoned ice-house will soon fill with ice caused by melting during these critical periods.

"When properly built and used according to custom, an ice-house proves every bit as good as a walk-in freezer although the process of freezing is, of necessity, a great deal slower. Proper ventilation is carried out with top and bottom ventilators built into the chamber. This is a MUST or the ice-house will not function as such."

In a personal communication, the Venerable Archdeacon D.B. Marsh discusses the comparative efficiency of several ice-houses which he has seen in the North and stresses the need for additional insulation over the overburden.

"Over the Mission Ice House at Eskimo Point, muskeg insulation was placed around for yards and kept the ice house completely frozen at all times of the year. The R.C.M.P. ice house was a failure because the walls were not insulated and the heat and water got in. At Aklavik the ice house (Anglican Mission) was dug out at the bottom of a long shaft and in spite of the depth, in the hottest months everything froze – the reverse was true in winter."

Side Elevation

WESTERN TYPE 'ICE HOUSE' 15'X15'X20'
USING DRIFT WOOD FOR SHORING & FLOORING

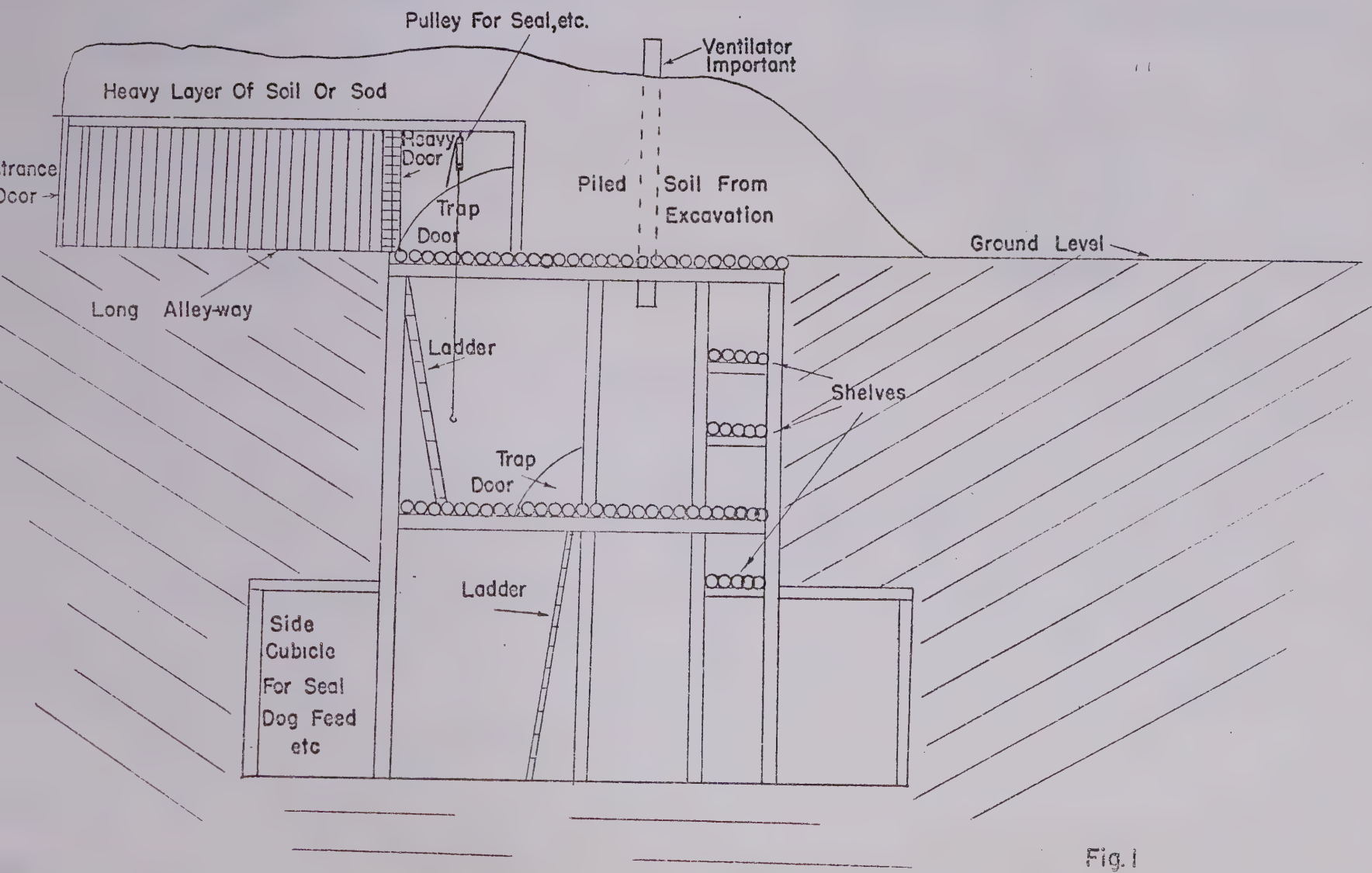
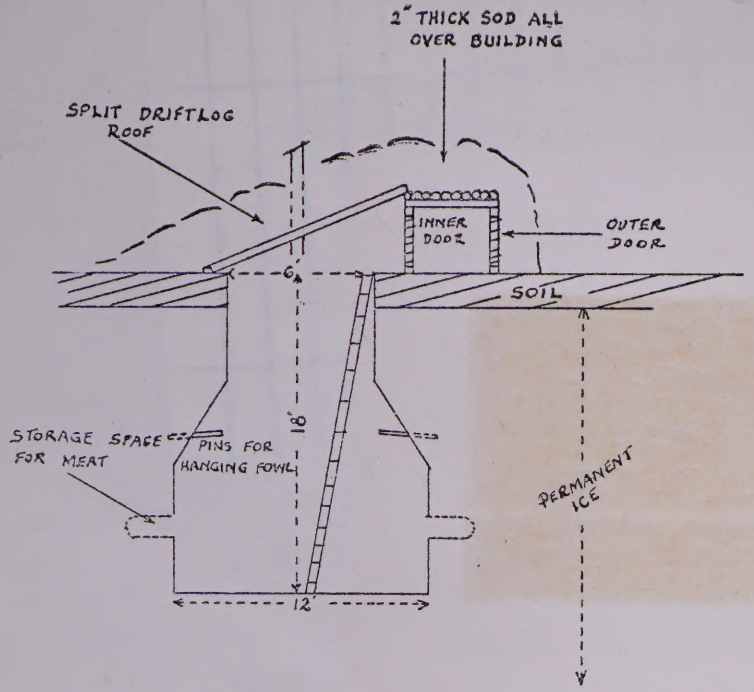
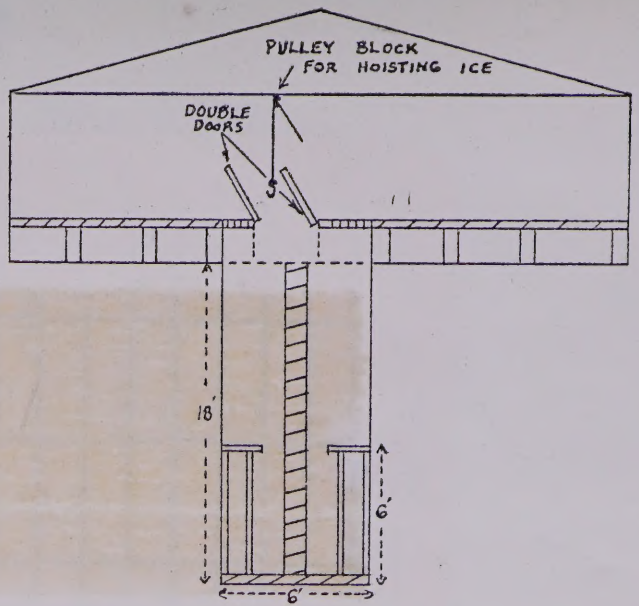


Fig. I

ICE HOUSE



ICE HOUSE



HERSCHEL ISLAND
ICE HOUSE

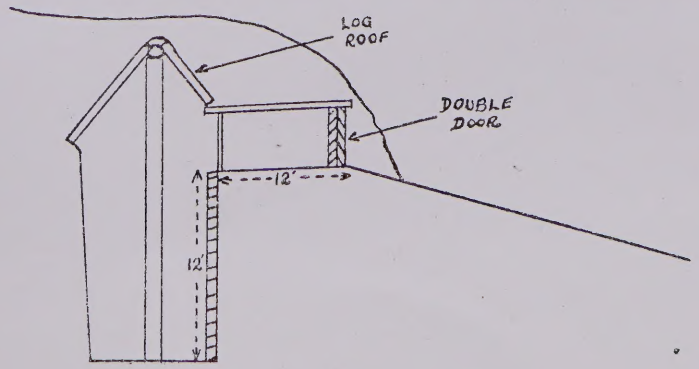


Fig. 2